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11-13-00

PTO/SB/05 (2/98)

UTILITY PATENT APPLICATION TRANSMITTAL

(Only for nonprovisional applications under 37 CFR § 1.53(b))

Attorney Docket No.	CROSS1330-1
First Inventor or Application Identifier	Robert Allen Reynolds
Title	Method and System for Mapping Addressing of SCSI Devices Between Storage Area Networks
Express Mail Label No.	EL781633676US

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

ADDRESS TO: Box Patent Application
Assistant Commissioner for Patents
Washington, D.C. 20231

1. [X] Fee Transmittal for FY 2000 *(Submit an original and a duplicate for fee processing)*
2. [X] Specification [Total Pages] 27 *(preferred arrangement set forth below)*
   - Descriptive Title of the Invention
   - Cross References to Related Applications
   - Statement Regarding Fed sponsored R & D
   - Reference to Microfiche Appendix
   - Background of the Invention
   - Brief Summary of the Invention
   - Brief Description of the Drawings *(if filed)*
   - Detailed Description
   - Claim(s)
   - Abstract of the Disclosure
3. [X] Drawing(s) *(35 USC 113)* [Total Sheets] 4
4. Oath or Declaration [Total Pages] 2
   a. [X] (Unsigned)
   b. [ ] Copy from a prior application (37 CFR 1.63(d)) *(for continuation/divisional with Box 17 completed)*
      i. [ ] DELETION OF INVENTOR(S) Signed statement attached deleting inventor(s) named in the prior application, see 37 CFR 1.63(d)(2) and 1.33(b)
5. [ ] Incorporation By Reference *(useable if box 4b is checked)*. The entire disclosure of the prior application, from which a copy of the oath or declaration is supplied under Box 4b, is considered to be part of the disclosure of the accompanying application and is hereby incorporated by reference therein.
6. [ ] Microfiche Computer Program *(Appendix)*
7. Nucleotide and Amino Acid Sequence Submission *(if applicable, all necessary)*
   a. [ ] Computer-Readable Copy
   b. [ ] Paper Copy (identical to computer copy)
   c. [ ] Statement verifying identity of above copies

ACCOMPANYING APPLICATION PARTS

8. [ ] Assignment Papers (cover sheet & document(s))
9. [ ] 37 CFR 3.73(b) Statement *(when there is an assignee)* [X] Power of Attorney (Unexecuted)
10. [ ] English Translation Document *(if applicable)*
11. [ ] Information Disclosure Statement (IDS)/PTO-1449 [ ] Copies of IDS Citations
12. [ ] Preliminary Amendment
13. [X] Return Receipt Postcard
14. [ ] Small Entity Statement(s) [ ] Statement filed in prior application, Status still proper and desired
15. [ ] Certified Copy of Priority Document(s) *(if foreign priority is claimed)*
16. [X] Other: Certificate of Express Mail
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17. If a CONTINUING APPLICATION, *check appropriate box and supply the requisite information below and in a preliminary amendment*

[ ] Continuation [ ] Divisional [ ] Continuation-In-Part (CIP) of prior Application No.: _____

Prior application information: Examiner _____ *Group / Art Unit* _____

[ ] Claims the benefit of Provisional Application No. 60/165,385

CORRESPONDENCE ADDRESS

Armando Pastrana, Jr.
Gray Cary Ware & Freidenrich LLP
100 Congress Avenue, Suite 1440
Austin, Texas 78701-4042
(512) 457-7080 *phone*
(512) 457-7070 *fax*

TYPED or PRINTED NAME Armando Pastrana, Jr. REGISTRATION NO. 44,997

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First Named Inventor	Robert Allen Reynolds
Examiner Name	
Group / Art Unit	
Attorney Docket No.	CROSS1330-1

METHOD OF PAYMENT (check one)

1. [X] The Commissioner is hereby authorized to charge any underpayment of fees and credit any over payments to:

Deposit Account Number: 50-0456

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[ ] Applicant claims small entity status. See 37 CFR 1.27

2. [X] Payment Enclosed:

[X] Check [ ] Money Order [ ] Other

FEE CALCULATION

1. BASIC FILING FEE

Large Entity Code	$	Small Entity Code	$	Fee Description	Fee Paid
101	710	201	355	Utility Filing Fee	710
106	320	206	160	Design Filing Fee	
107	490	207	245	Plant Filing Fee	
108	710	208	355	Reissue Filing Fee	
114	150	214	75	Provisional Filing Fee	

SUBTOTAL (1) ($) 710.00

2. EXTRA CLAIM FEES

			Extra Claims X	Fee from below =	Fee Paid
Claims	22	-20**	2	18	26
Ind. Clms	3	-3**	0		0
Multiple Dependent Claims					

Large Entity Code	$	Small Entity Code	$	Fee Description
103	18	203	9	Claims in excess of 20
102	80	202	40	Indep. claims in excess of 3
104	270	204	135	Multiple dependent claim, if not paid
109	80	209	40	Reissue indep. claims over original patent
110	18	210	9	Reissue claims in excess of 20 and over original patent

SUBTOTAL (2) ($)36.00

**=number previously paid, if greater; For Reissues, see above

FEE CALCULATION (continued)

3. ADDITIONAL FEES

Large Entity Code	$	Small Entity Code	$	Fee Description	Fee Paid
105	130	205	65	Surchrg – late filing fee or oath	
127	50	227	25	Surcharge – late provisional filing fee or cover sheet	
139	130	139	130	Non-English Specification	
147	2520	147	2520	Filing a request for ex parte reexamination	
112	920*	112	920*	Request publication of SIR prior to Examiner action	
113	1840*	113	1840*	Request publication of SIR after Examiner action	
115	110	215	55	Extension for reply within first month	
116	390	216	195	Extension for reply within second month	
117	890	217	445	Extension for reply within third month	
118	1390	218	695	Extension for reply within fourth month	
128	1890	228	945	Extension for reply within fifth month	
119	310	219	155	Notice of Appeal	
120	310	220	155	Filing a brief in support of an appeal	
121	270	221	135	Request for oral hearing	
138	1510	138	1510	Petition to institute a public use proceeding	
140	110	240	55	Petition to revive: unavoidable	
141	1240	241	620	Petition to revive: unintentional	
142	1240	242	620	Utility issue fee (or reissue)	
143	440	243	220	Design issue fee	
144	600	244	300	Plant issue fee	
122	130	122	130	Petitions to the Commissioner	
123	50	123	50	Petitions related to provisional applications	
126	240	126	240	Submission of Information Disclosure Statement	
581	40	581	40	Recording each patent assignment per property (times number of properties)	
146	710	246	355	Filing a submission after final rejection (37 CFR § 1.129(a))	
149	710	249	355	Each additional invention to be examined (37 CFR § 1.129(b))	
179	710	279	355	Request for Continued Examination (RCE)	
169	900	169	900	Request for expedited examination of a design application	

Other fee (specify) _____

*Reduced by Basic Filing Fee Paid SUBTOTAL (3) ($)

SUBMITTED BY:				Complete (if applicable)	
Name (Print/Type)	Armando Pastrana, Jr.	Registration No. (Attorney/Agent)	44,997	Telephone	(512) 457-7000
Signature				Date	11/9/00

Gray Cary\AU\4045571.1 103671-991300

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF MAILING BY "EXPRESS MAIL"	Atty Docket No. (Optional) **CROSS1330-1**

In the Application of: **Robert Allen Reynolds, John Brent Haechten and Kenneth Donald Smeltzer**
Date Filed: **November 10, 2000**
Title: **METHOD AND SYSTEM FOR MAPPING ADDRESSING OF SCSI DEVICES BETWEEN STORAGE AREA NETWORKS**

Attn: Box Patent Application
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Sir:

I hereby certify that the enclosures listed below are being deposited with the United States Postal Service "EXPRESS MAIL Post Office to Addressee" service under 37 C.F.R. § 1.10, Mailing Label Certificate No. EL781633676US, on November 10, 2000, addressed to Box Patent Application, Assistant Commissioner for Patents, Washington, DC 20231.

Respectfully submitted,

GRAY CARY WARE ▲ FREIDENRICH LLP

Printed Name: LAURA H ANDRE

Enclosures:

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Check No. 459576 for $746.00 for Utility Application Filing Fee
Form PTO SB/05
General Authorization Under 37 C.F.R. § 1.136(a)(3) and Fee Transmittal (+ copy)
Specification, Claims, Abstract (28 Pages)
Sheets of Drawings (4 Pages, 4 Figures)
Unsigned Declaration and Power of Attorney
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103671-991330

METHOD AND SYSTEM FOR MAPPING ADDRESSING OF SCSI DEVICES BETWEEN STORAGE AREA NETWORKS

This application claims the benefit of U.S. Provisional Application 60/165,385, which was filed on November 12, 1999 and is hereby incorporated in reference herein.

TECHNICAL FIELD OF THE INVENTION

This invention relates generally to data and information communication systems and their operation and, more particularly, to the field of storage area networking. Even more particularly, the present invention relates to fibre channel storage area networks ("SANs") and to a method and system for mapping addressing of SCSI devices between two SANs.

BACKGROUND OF THE INVENTION

Dramatic growth in the amount of data that must be stored, combined with the need for faster, more reliable and more efficient data access and data management capabilities, have led many organizations to seek an improved way of storing, accessing and managing data. In traditional computer networks, each storage device is connected to only one server, and can be accessed only by that server. The computer protocol used to connect and transfer data between the server and storage device is called the small computer system interface, or SCSI. As more data must be stored and retrieved, organizations increasingly are finding that this one-to-one, or point-to-point, connection is not sufficiently fast, efficient and reliable to support growing demands for data access and storage. In addition, in most organizations today, data back-up -- or creating a duplicate copy of data to protect it from corruption or loss -- is accomplished by moving large volumes of stored data from a dedicated storage device over the primary computer network to a back-up storage device. Since the primary computer network also is responsible for conducting day-to-day computer operations, this added data movement results in substantial congestion, slowing all other computer operations.

Storage area networks, or SANs, which are computer networks dedicated to data storage, can help resolve some of these problems. A storage area network uses a different, higher-performance computer protocol, known

as Fibre Channel, to transfer data. A storage area network also removes the one-to-one connection between servers and storage devices, and instead allows many servers to connect to and share access with many storage devices. The many-to-many connection enabled by the storage area network, combined with the Fibre Channel protocol, permits faster, more efficient, more reliable and more manageable data transfer processes. Furthermore, the storage area network, can be accomplished over data back-up operations, instead of over the primary computer network, thus substantially reducing congestion on the primary computer network and allowing much more efficient day-to-day operations.

Most storage devices in the market, however, continue to be sold with the small computer system interface. Additionally, most organizations have made significant investments in storage devices and servers that use the small computer system interface. Therefore, in order for devices of a Fibre Channel storage area network to function with storage devices that use SCSI, storage routers must be installed between these devices. In particular, storage routers are essential to shifting data back-up processes from a primary computer network to the storage area network, since most data back-up storage devices use the SCSI interface and can only connect to the storage area network through a storage router. As new computer protocols are introduced, storage routers will be increasingly essential to enable rapid, seamless communication among servers, storage devices and

storage area network devices that use diverse protocols.

However, typical SANs are local Fibre Channel networks that serve one particular organization or one particular site. These SANs can be quite large, but cannot span great distances as they have distance limitations imposed upon them by the infrastructure necessary to carry Fibre Channel. For example, the Fibre Channel standard defines a means to communicate over spans up to 10 km and, in some cases, up to 30 km in length. In order to do this, however, the organization implementing the Fibre Channel network must typically own the fiber or lease dark fiber from some other party, which can be very expensive and, in most cases, is cost prohibitive.

This is because the fibers used to carry Fibre Channel traffic can carry only Fibre Channel protocol traffic. They cannot be shared with other protocols. It is therefore more cost effective to transmit data over long distances using a protocol that can be carried over already existing networks, such as those owned by phone companies that can carry ATM traffic, SONET traffic and IP traffic. Therefore, SANs are usually limited as to the geographic area that they can serve (i.e., they are limited to local operation). Furthermore, two or more geographically diverse SANs cannot inter-connect in a seamless fashion such that they operate and behave as if they were local to one another because the infrastructure to connect them does not exist or is cost prohibitive.

Related U.S. Patent Application entitled "*Encapsulation Protocol for Linking Storage Area Networks Over a Packet Based Network*" Serial No. 60/165,194, filed on November 12, 1999, (the "Encapsulation" patent application) discloses an encapsulation protocol for linking storage area networks over a packet-based network that addresses the problems discussed above. The Encapsulation application is hereby incorporated by reference in its entirety. However, even with the solutions provided by the Encapsulation application, connecting two or more SANs together using an extender, such as the encapsulation protocol of the Encapsulation application, requires the addresses of SCSI devices from one SAN to be mapped to an intermediate address to get across the extender, and then to be mapped to another address on a remote SAN. This must be done in order for initiators (hosts) on one SAN to be able to address SCSI devices on a remote SAN as if they were SCSI devices on the local SAN to which the initiator is attached. These mappings should be done in a generic fashion so that different types of architectures (i.e., parallel BUS, Fibre Channel Protocol, etc.) containing SCSI devices can all be mapped using the same method.

Some solutions do exist for mapping the addressing of SCSI devices between two SANs, but these typically attempt to propagate the entire address of a SCSI device across the extender and re-use the same address on the remote SAN. For example, a parallel BUS SCSI device on a first SAN may have an address of BUS:0,

target:1, and LUN (logical unit identifier):0. In prior art methods and systems, the extender propagates this information from the first SAN to a remote SAN, where the same address is used to identify the device on the remote SAN. This approach, however, has a twofold problem. One, it uses a method of address mapping that is limited to a single type of architecture, i.e., the method only provides for mapping a single type of SCSI architecture SCSI device (e.g., parallel BUS SCSI devices). Two, because the device address must be the same on both sides of the extender, there is no means to dynamically map SCSI devices across the extender.

SUMMARY OF THE INVENTION

Therefore, a need exists for a method and system for mapping addressing of SCSI devices between two SANs connected by a SAN extender (transport layer) that can map SCSI device addresses in a generic fashion such that SCSI device architecture can be mapped using the same method.

Still further, a need exists for a method and system for mapping addressing of SCSI devices between two SANs that can dynamically map SCSI device addresses across a SAN extender.

The present invention provides a method and system for mapping addressing of SCSI devices between two SANs connected by a SAN extender over a packet-based network that can substantially eliminate or reduce the disadvantages and problems associated with use of a fibre channel protocol over large distances. In particular, the present invention provides a means for seamlessly interconnecting geographically distinct SANs, such that they operate as if they were local to one another by providing a means to generically and dynamically map SCSI device addresses between two SANs.

In particular, the present invention provides a method and system for accessing a device from a host, wherein the host and device are in separate SANs interconnected by a transport layer, and wherein the interface between the transport layer and the host SAN is a host node and the interface between the device SAN and the transport layer is a target node. The method of this invention comprises the steps of: at the

target node, mapping the device address into a Target, Generic Identifier, and mapping the generic identifier into a transport identifier for identifying the device on the transport protocol; and, at the host node, mapping the device's transport identifier into a host generic identifier, and mapping the host generic identifier into an address accessible by the host. Each node can be a fibre channel-to-SCSI router, such as those manufactured by Crossroads Systems Inc., of Austin, Texas. The host generic identifier can comprise a mapping from the target node transport protocol address combined with the target generic identifier. The transport layer can be a packet-based network over which a SAN extender carries the FC protocol.

The present invention provides an important technical advantage of a method and system for mapping addressing of SCSI devices between two SANs connected by a SAN extender that can map SCSI device addresses in a generic fashion, such that any SCSI device architecture can be mapped using the same method.

Further still, the present invention provides an important technical advantage of a method and system for mapping addressing of SCSI devices between two SANs that can dynamically map SCSI device address across a SAN extender.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete understanding of the present invention and the advantages thereof may be acquired by referring to the following description, taken in conjunction with the accompanying drawings in which like reference numbers indicate like features and wherein:

FIGURE 1 is a simplified block diagram illustrating one implementation of the method and system of this invention within a typical SAN environment.

DETAILED DESCRIPTION OF THE INVENTION

Preferred embodiments of the present invention are illustrated in the FIGUREs, like numerals being used to refer to like and corresponding parts of various drawings.

The present invention provides a method and system for mapping addressing of SCSI devices between two SANs connected by a SAN extender across a packet-based network that take advantage of existing telecommunication networks to efficiently and cost-effectively connect multiple, and perhaps geographically diverse, SANs such that they can operate as if they were a single storage area network. Host devices on one SAN can therefore access target devices on a remote SAN as if the two were part of a single SAN. The method and system of this invention can thus effectively overcome the distance limitations of existing fibre channel networks so that the SAN model can be extended to many SANs over many miles. The present invention could, for example, be used to link a corporate SAN in Los Angeles to another corporate SAN in New York City or Tokyo. In the case of storage recovery, this invention will allow a backup library to reside off site at a remote location, thus ensuring data integrity should the local location be damaged by disaster, like fire or flood. SANs implementing the present invention thus need not be limited to local use only.

To connect local SANs over greater distances than allowed under the fibre channel protocol, the present

invention can work together with the SAN extender disclosed in the Encapsulation application. The Encapsulation application defines an encapsulation protocol ("EP") that runs the Fibre channel protocol in such a way that it can travel over any packet-based transport, such as an asynchronous transfer mode ("ATM") or Ethernet network. Together with the extender disclosed in the Encapsulation application, the current invention provides a mechanism for generically mapping the addressing of SCSI devices on a SAN to one or more remote SANs, across any transport layer that is used to connect the SANs (e.g., ATM, gigabit Ethernet, or Fibre Channel).

A node (Fibre Channel-to-SCSI router) is used to connect each SAN to the extender transport maintains two mapping tables, as discussed more fully below, to map device addresses across the transport protocol to another node. The nature of the tables maintained by a node depends on whether the node is a host node, or a target node. This distribution is described more fully below.

The nodes at either end of the extender transport connecting any two SANs build their mapping tables slightly differently, depending on whether they are the target node or the host (initiator) node. A target node (to which target devices are attached) builds tables to map a SCSI device addresses into first a target generic identifier, and then to a transport identifier an (address) that is used on the extender transport protocol. An initiator node (the node to

which hosts seeking to access a target device are attached) builds tables to map the address received from the extender protocol (the transport identifier) back into a valid SCSI device address based on the current architecture (e.g., parallel BUS, fibre channel, etc.) This method is explained more fully below.

According to the teachings of this invention, a target node first maps a SCSI device address to a target generic identifier on the target node. This target generic identifier can then be mapped into a transport identifier that is used as a device identifier on the extender transport. The target generic identifier and the transport identifier can, in some, instances, be the same. The target node informs the initiator node of the device transport identifier and also of the address of the target node on the extender transport. The initiator node is thus provided with the information needed to determine the target node that owns the SCSI device and also with the device transport identifier for the particular device. The initiator node can then map the target node address and device transport identifier to a host generic identifier on the initiator node, and then maps the host generic identifier to an address that can be presented to initiators on the local initiator SAN.

FIGURE 1 is a simplified block diagram illustrating one implementation of the method and system of this invention within a typical SAN environment. Network 100 of FIGURE 1 includes #1 host

SAN 110 and #2 host SAN 112, which can be local fibre channel SANs. #1 host SAN 110 and #2 host SAN 112 can access target SAN 115, which can also be a local fibre channel SAN for, for example, tape backup and disk mirroring. #1 host SAN 110 is communicatively connected to #1 initiator node 120, and #2 host SAN 112 is communicatively connected to #2 initiator node 130. Target SAN 115 is communicatively connected to target node 150. #1 initiator node 120, #2 initiator node 130, and target node 150 can be fibre channel-to-SCSI routers, such as those manufactured and sold by Crossroads Systems Inc. of Austin, Texas. Nodes 120, 130 and 150 can be interfaces to the rest of the network 100 for SANs 110, 112 and 115.

The Fiber channel-to-SCSI routers that nodes 120, 130 and 150 comprise can all implement the EP layer (as disclosed in the Encapsulation application) such that the fibre channel protocol flows seamlessly over the packet-based WAN (wide area network) 140. WAN 140 represents a physical packet-based transport, such as ATM or Ethernet. WAN 140 can be a dedicated link or switched network. SANs 110, 112 and 115 are connected to their respective nodes via fibre channel links 190. Nodes 120, 130 and 150 can each be connected to WAN 140 via network links 192. Fibre channel links 190 can be copper, Fibre optic links, or any other such network link as known to these familiar with the art, as required for a given application. Network links 192 can similarly be any such network link, as needed.

#1 host SAN 110, #2 host SAN 112, and target SAN 115 can comprise multiple initiators and multiple targets, respectively. For example, target SAN 115 includes fibre channel hub (switch) 160, tape library 170, and disk 180. Although only tape library 170 and disk 180 are shown, multiple initiators and target devices can be attached to fibre channel hub 160 and through it to fibre channel-to-SCSI router (target node) 150. Target SAN 115 can thus comprise multiple hosts and multiple initiators.

The method and system of the present invention require an extender protocol to connect the two or more SANs between which target addresses will be mapped.

The Encapsulation Application discloses such an extender protocol (EP). The method and system for mapping SCSI addresses of the present invention uses this encapsulation protocol to provide a transport on which to carry the mapping used to allow initiators on one SAN to address SCSI devices on a remote SAN as if they were SCSI devices on the local SAN to which the initiator is attached. Devices on a remote SAN thus can be represented in such a way that they are made available to initiators on other SANs. The Encapsulation Application discloses a compatible encapsulation protocol that can be used with the present invention.

FIGURE 1 illustrates how the method and system of this invention can be used to map SCSI device addresses between Fibre channel SANs interconnected over a network protocol, such as an ATM network. The example

of FIGURE 1 is used for illustrative purposes only, and does not preclude using the method and system of this invention for mapping other SCSI architecture device addresses or using a different protocol to interconnect the SANs.

To accomplish the mapping of the method and system of this invention, target node 150 will build two tables. The first table maps the address information for each SCSI device attached to target node 150 into a unique target generic identifier for each SCSI device. For example, if tape library 170 and disk 180 have FC addresses 0x1 and 0x2, respectively, and tape library 170 has two logical unit identifiers (LUNs) of 0 and 1, and disk 180 has a single LUN of 0, then the following table is created by target node 150 to map the SCSI device addresses to target generic identifiers.

TABLE 1

Target Generic Identifier	FC Device Address	LUN Identifier
0	0x1	0
1	0x1	1
2	0x2	0

Target node 150 uses the target generic identifiers to map each device address into a transport identifier that can then be used to identify the device on the extender transport protocol. In this example, the device transport identifier on the extender transport protocol is the same as the generic identifier. However, this need not be the case, as other identifiers could instead be used. Table 2 below

shows the mapping of target generic identifier to device transport identifier.

TABLE 2

Target Generic Identifier	Transport Identifier
0	0
1	1
2	2

Once Tables 1 and 2 are created, target node 150 can inform #1 initiator node 120 and #2 initiator node 130 of the target devices it has made available and their respective transport identifiers. The method for notifying other nodes in the network can be any method as known to those familiar in the art.

#1 initiator node 120 and #2 initiator node 130 each similarly build two tables. The first table that each initiator node creates is used to map the target node's transport protocol address and each device transport identifier generated by target node 150 into a host initiator generic identifier within the local node. The host generic identifier associated with a given target device represents a combination of the target node transport protocol address and the devices transport identifier. Assuming for this example that target node 150 has an ATM address of 0x01020304, then the following Table 3 would be created in #1 initiator node 120 and #2 initiator node 130.

TABLE 3

Host Generic Identifier	Target Node Transport Address	Transport Identifier
0 (Tape)	0x01020304	0 (Tape)
1 (Tape)	0x01020304	1 (Tape)
2 (Disk)	0x01020304	2 (Disk)

In this example, all devices attached to target node 150 are made available to #1 initiator node 120 and #2 initiator node 130. However, a target node, such as target node 150, may decide to make only selected devices accessible to initiator nodes by leaving selected SCSI device addresses out of the tables it generates for the mapping. Such different mapping configurations are intended to be within the scope of this invention. Any combination of such mappings is contemplated by this invention.

#1 initiator node 120 and #2 initiator node 130 also build a table, such as Tables 4 and 5 below, that map the host generic identifier into a form that can be used by hosts on the local SAN to address the target devices. In the examples shown below in Tables 4 and 5, the host generic identifiers are mapped into LUNs on a single fibre channel target. This fibre channel target is a simulated target within the host SAN that is sued to represent the remote target devices on target SAN 115 so that local hosts can access each device.

TABLE 4

FC LUN (Initiator SAN on target)	Host Generic Identifier
0	1 (Tape)
1	0 (Tape)
2	2 (Disk)

TABLE 5

FCLUN	Host Generic Identifier
0	2 (Disk)

The method and system of this invention can thus use a simulated target at a host SAN, onto which the can map the addresses of one or more real target devices located at a remote target SAN. The simulated fibre channel target to which the host generic identifier(s) are mapped can then be used to access the remote target device as if the remote target(s) were located within the local SAN.

The method and system of this invention do not preclude other mappings from occurring, i.e., each host generic identifier could instead be mapped to a unique simulated fibre channel target within the local host SAN. Any combination of such mappings can be used and is within the scope of this invention. In fact, initiator nodes may decide to map only selected target devices or to map all target devices. Target devices can also be mapped in any order. For example, in Table 4 above, #1 initiator node 120 has mapped all of

the target devices from target SAN 115 into a simulated fibre channel target, but in a different order. Host generic identifier 1 is mapped to Fibre Channel LUN 0, host generic identifier 0 is mapped to Fibre Channel LUN 1, and host generic identifier 2 is mapped to Fibre Channel LUN 2. Any such combination is within the scope of this invention. By contrast, #2 initiator node 130 in this example maps only one target device, associated with host generic identifier 2, into a Fibre Channel LUN 0.

By using these mapping tables, initiators on local SANs connected to #1 initiator node 120 and #2 initiator node 130 can access the SCSI target devices on target SAN 115 connected to target node 150. According to the teachings of this invention, all such remote target devices, or a limited number of such devices, can be made accessible to remote initiator SANs from a local target SAN. The present invention thus allows any type of SCSI target device to be accessed across any type of extender protocol by mapping the device addresses in a generic fashion. In addition, the method and system of this invention provide the capability to access all such target devices, or only a limited number of such target devices, on a target SAN from one or more remote initiator SANs, depending on the mapping tables created. The present invention also allows multiple SANs of different architectures and protocols to be interconnected in a generic fashion.

The method and system of this invention can be implemented within a fibre channel-to-SCSI router, such as routers 120, 130 and 150 of FIGURE 1 (nodes 120, 130 and 150). The present invention can be implemented purely as computer executable software instructions stored in memory within the fibre channel-to-SCSI routers, and can be easily upgraded as new versions with new functionality are created. No change in the hardware of existing fibre channel-to-SCSI routers is required to incorporate this invention. The memory in which the software instructions of this invention can be stored can be RAM (random access memory) or ROM (read-only memory) or other such memory storage devices.

The method and system of this invention can be used with any compatible encapsulation protocol, such as that disclosed in the Encapsulation Application, and can be used over existing Internet infrastructures and other existing network protocols. For example, the extension protocol can be a typical IP network protocol, an ATM network, gigabit Ethernet, or any protocol that allows data packets to flow between nodes. The method and system of this invention allows for mapping of SCSI device addresses between any SCSI protocol SANs on either end of an extension network.

The present invention is not limited to use in applications having storage area networks that each use the same fibre channel protocol. For example, target host 115 and initiator hosts 110 and 112 of FIGURE 1 can each use a different protocol and the method and

system for mapping SCSI target device addresses of this invention can continue to function as disclosed herein. However, a compatible encapsulation protocol is required.

The present invention provides the capability for extending a SAN model to many SANs over distances much greater than those currently allowed by the fibre channel protocol. This invention provides the capability to interconnect SANs in geographically diverse locations, such as different cities, in such a way that they can function in a seamless manner as if they comprise a single local SAN. Further, for storage recovery purposes, the present invention allows a backup library to reside off site at a remote location, thus ensuring data integrity should the local location be damaged by some failure or disaster.

Although the present invention has been described in detail herein with reference to the illustrative embodiments, it should be understood that the description is by way of example only and is not to be construed in a limiting sense. It is to be further understood, therefore, that numerous changes in the details of the embodiments of this invention and additional embodiments of this invention will be apparent to, and may be made by, persons of ordinary skill in the art having reference to this description. It is contemplated that all such changes and additional embodiments are within the spirit and true scope of this invention as claimed below.

WHAT IS CLAIMED IS:

1. A system for mapping addresses of SCSI devices, comprising:

a plurality of storage area networks on which is located at least one device and/or at least one host; and

a storage area network extender that connects said at least two storage area networks over a packet-based network, wherein at least one host on any storage area network is operable to access at least one device located on any storage area network of said plurality of storage area networks.

2. The system for mapping addresses of SCSI devices of Claim 1, wherein said storage area network extender seamlessly interconnects said at least two storage area networks.

3. The system for mapping addresses of SCSI devices of Claim 2, wherein said plurality of storage area networks are geographically distinct.

4. The system for mapping addresses of SCSI devices of Claim 1, wherein said storage area network extender further comprise a plurality of nodes.

5. The system for mapping addresses of SCSI devices of Claim 4, wherein within said nodes, device addresses are mapped to an intermediary device

identifier, which in turn is mapped into an address accessible by said host.

6. The system for mapping addresses of SCSI devices of Claim 5, wherein said nodes comprise a Fibre channel-to-SCSI router.

7. The system for mapping addresses of SCSI devices of Claim 5, wherein said intermediary device identifier comprises:

a node identifier; and

a generic device identifier.

8. The system for mapping addresses of SCSI devices of Claim 5, wherein each of said nodes is operable to inform said plurality of nodes of said at least one device located on said storage area network to which said node is interfaced.

9. The system for mapping addresses of SCSI devices of Claim 5, wherein said plurality of storage area networks communicate via an encapsulation protocol.

10. A method for mapping addresses of SCSI devices, comprising the steps of:

identifying a host located on a first storage area network;

identifying a device located on at least one additional storage area network;

interconnecting said first storage area network with said at least one additional storage area network via a transport layer;

mapping a device address into an intermediary device identifier; and

mapping said intermediary device identifier into an address accessible by said host.

11. The method of Claim 10, wherein an interface between said transport layer and said first storage area network or said at least one additional storage area network comprises a node.

12. The method of Claim 11, wherein said step of mapping a device into said intermediary device identifier takes place at each node.

13. The method of Claim 11, wherein said step of mapping said intermediary device identifier into an address accessible by said host takes place at each node.

14. The method of Claim 11 wherein said nodes comprise a Fibre channel-to-SCSI router.

15. The method of Claim 14, wherein said intermediary device identifier comprises:

a node identifier; and

a generic device identifier.

16. The method of Claim 15, wherein said transport layer comprises a packet-based network.

17. The method of Claim 11, wherein said storage area networks are geographically distinct.

18. A system for mapping addresses of SCSI devices, comprising:

a SCSI device located on a first storage area networks within a plurality of storage area networks;

a host located on a second storage area network within said plurality of storage area networks; and

a plurality of nodes that connect said plurality of storage area networks to a packet-based network, wherein said nodes seamlessly interconnect said plurality of storage area networks, allowing said host to access said device.

19. The system for mapping addresses of SCSI devices of Claim 18, wherein within said nodes device addresses are mapped to an intermediary device identifier, which in turn is mapped into an address accessible by said host.

20. The system for mapping addresses of SCSI devices of Claim 18, wherein at least a pair of said storage area networks within said plurality of storage area networks are geographically distinct.

21. The system for mapping addresses of SCSI devices of Claim 18, wherein said nodes comprise a Fibre channel-to-SCSI router.

22. The system for mapping addresses of SCSI devices of Claim 18, wherein said intermediary device identifier comprises:

a node identifier; and

a generic device identifier.

METHOD AND SYSTEM FOR MAPPING ADDRESSING OF SCSI DEVICES BETWEEN STORAGE AREA NETWORKS

ABSTRACT OF THE INVENTION.

The present invention provides a method and system for mapping addressing of SCSI devices between two SANs connected by a SAN extender over a packet-based network with use of a Fibre channel protocol over large distances. The present invention seamlessly interconnects graphically distinct SANs such that they operate as if they were local to one another by providing a means to generically and dynamically map SCSI device addresses between two SANs. The present invention provides a method and system for accessing a device from a host, wherein the host and device are in separate SANs interconnected by a transport layer, and wherein the interface between said transport layer and each of said SANs is a node. This method comprises, at each node, the steps of: mapping the device address into an intermediary device identifier, and mapping the intermediary device identifier into an address accessible by the host. Each node can be a Fibre channel-to-SCSI router, and the intermediary device identifier can comprise a node identifier and a generic device identifier. The transport layer can be a packet-based network.

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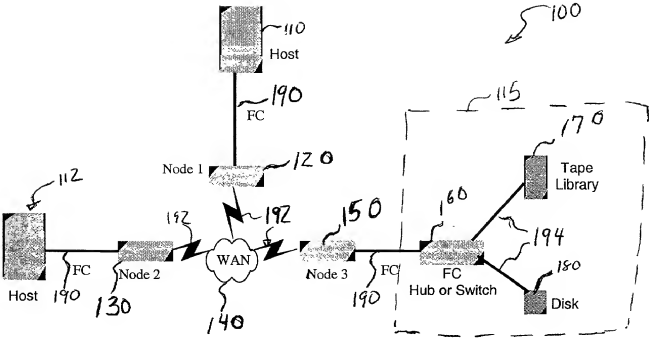

FIG. 1

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PTO/SB/01

DECLARATION FOR UTILITY OR DESIGN PATENT APPLICATION (37 CFR 1.63)

[X] Unsigned Declaration Submitted with Initial Filing

[ ] Declaration Submitted after Initial Filing

Attorney Docket No.	CROSS1330-1
First Named Inventor	Robert Allen Reynolds
COMPLETE IF KNOWN	
Application Number	
Filing Date	November 10, 2000
Group Art Unit	
Examiner Name	
Customer ID No.	25094

As a below named inventor, I hereby declare that:

My residence, post office address, and citizenship are as stated below to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

Method and System for Mapping Addressing of SCSI Devices Between Storage Area Networks

(Title of Invention)

the specification of which was filed on (MM/DD/YYYY) [ ]

[ ] as United States Application Number of PCT International Application Number

and was amended on (MM/DD/YYYY) *(if applicable)* [ ]

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment specifically referred to above.

I hereby state I do not know and do not believe that said invention, design or discovery was ever known or used in the United States of America before my invention or discovery thereof, or patented or described in any printed publication in any country before my invention or discovery thereof, or more than one year prior to this application, or in public use or on sale in the United States of America more than one year prior to this application; that said invention, design or discovery has not been patented or made the subject of an inventor's certificate issued prior to the date of this application in any country foreign to the United States of America on an application filed by me or my legal representatives or assigns; and that I acknowledge the duty to disclose to the U.S. Patent and Trademark Office all information known to me which is material to the patentability as defined in 37 CFR 1.56.

I hereby claim foreign priority benefits under 35 U.S.C. 119(a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or of any PCT international application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application Number(s)	Country	Foreign Filing Date (MM/DD/YYYY)	Priority Not Claimed	Certified Copy Attached? YES	NO

Additional foreign application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto:

I hereby claim the benefit under 35 U.S.C. 119(e) of any United States provisional application(s) listed below:

Application Number(s)	Filing Date (MM/DD/YYYY)	
60/165,385	11/12/99	[ ] Additional provisional application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto

DECLARATION -- Utility or Design Patent Application

I hereby claim the benefit under 35 U.S.C. 120 of any United States Application(s), or 365(c) of any PCT international application designating the United States of America, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of 35 U.S.C. 112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

U.S. Parent Application or PCT Parent Number	Parent Filing Date (MM/DD/YYYY)	Parent Patent Number *(If applicable)*

Additional U.S. or PCT international application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto.

As a named inventor, I hereby appoint the following registered practitioner(s) associated with **Customer ID NO. 25094** to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith. **Registered practitioner(s) name/Registration number listed below:**

WILLIAM N. HULSEY III, Reg. No. 33,402; STEVEN R. SPRINKLE, Reg. No. 40,825; STEPHEN E. REITER, Reg. No. 31,192; TERRANCE A. MEADOR, Reg. No. 30,298; GREGORY P. RAYMER, Reg. No. 36,647; DAVID F. KLEINSMITH, Reg. No. 40,050; BARRY N. YOUNG, Reg. No. 27,774; TIMOTHY W. LOHSE, Reg. No. 35,255; STANLEY H. KIM, Reg. No. 40,047; DARLENE W. HAYES, Reg. No. 33,899; RAMSEY R. STEWART, Reg. No. 38,322; ARMANDO PASTRANA, JR., Reg. No. 44,997; ROBERT A. MCLAUCHLAN, Reg. No. 44,924; HAYWARD VERDUN, Reg. No. 43,223; MARK L. BERRIER, Reg. No. 35,066 and GEORGE R. MEYER, Reg. No. 35,284.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Name of Sole or First Inventor:							
Given Name (first and middle [if any])				Family Name or Surname			
Robert Allen				**Reynolds**			
Inventor's Signature					Date		
Residence: City	**Pflugerville**	State	**TX**	Country	**United States**	Citizenship	**U.S.**
Post Office Address	**19117 Sotogrande Street**						
Post Office Address							
City	**Pflugerville**	State	**TX**	Zip	**78660**	Country	**United States**

Name of Additional Inventor:							
Given Name (first and middle [if any])				Family Name or Surname			
John Brent				**Haechten**			
Inventor's Signature					Date		
Residence: City	**Buda**	State	**TX**	Country	**United States**	Citizenship	**U.S.**
Post Office Address	**28 Country Oaks Drive**						
Post Office Address							
City	**Buda**	State	**TX**	Zip	**78610**	Country	**United States**

Name of Additional Inventor:							
Given Name (first and middle [if any])				Family Name or Surname			
Kenneth Donald				**Smeltzer**			
Inventor's Signature					Date		
Residence: City	**Austin**	State	**TX**	Country	**United States**	Citizenship	**U.S.**
Post Office Address	**13104 Medina River Way**						
Post Office Address							
City	**Austin**	State	**TX**	Zip	**78732**	Country	**United States**

Direct all correspondence to: CUSTOMER ID NO. 25094							
Name	**Armando Pastrana, Jr.**		**Gray Cary Ware & Freidenrich LLP**				
Address	**100 Congress Avenue, Suite 1440**						
City	**Austin**			*State*	**TX**	*Zip*	**78701-4042**
Country	**United States of America**	*Telephone*	**(512) 457-7080**		*Fax*	**(512) 457-7070**	